FOOD PREFERENCES OF CAPTIVE FERAL PIGS: A PRELIMINARY REPORT

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ABSTRACT

Attraction of feral pigs (Sus scrofa) with food baits has long been practiced in Hawai'i. However, controlled tests of pig food preferences have not been conducted. Two experiments with 13 individually caged animals in a specially constructed pen were conducted at Hawai'i Volcanoes National Park during the period December 1985-January 1986. In one experiment, the commercial pig food normally fed to the animals was offered with other foods, and in another it was not. Seven food choices were offered in each of the two experiments. Foods to be tested were chosen on the basis of low cost, odor, and availability in quantity, and were presented in a multiple choice, randomly ordered arrangement to each animal individually.

Each of the two experiments consisted of three one-hour trials per animal. Trials for a given animal were conducted on different days. At the start of each trial, an animal was introduced to the experimental pen where food was available. At the end of the one-hour period, the animal was removed from the experimental pen and the pen was cleaned for the next animal. Pigs were observed from an observation blind, and the following were recorded: 1) time spent feeding on a food item; 2) number of times spent feeding on an item; 3) amount of a food item consumed. In addition, initial food investigation (but not food consumption) was recorded when it occurred.

In the first series of tests, which did not include the choice of commercial pig food, corn mash was investigated first by seven of 13 pigs (one animal did not respond). Corn mash was the preferred food, based on time spent feeding (mean = 19.9 minutes), with papaya (mean = 14.2 minutes) and hapu'u logs (Cibotium glaucum) (mean = 5.6 minutes) following. In the second test, which did include the choice of commercial pig food, corn mash and hapu'u were the initial items investigated (four pigs each). Pig food was favored (mean = 14.0 minutes), followed by corn mash (mean = 9.4 minutes) and liver (mean = 8.2 minutes). Weights of food consumed and numbers of feeding bouts for each food generally corresponded to time spent feeding and were also used as a measure of preference. Some of the possible variables influencing choice of food are discussed.

INTRODUCTION

Feral pigs (Sus scrofa) threaten native ecosystems through enhancement of erosion and runoff; reduction of native plant populations such as lobeliads, mints, and lilies; and alteration of forest composition and diversity by encouragement of the invasion of weeds. Feral pigs even affect endangered birds such as the po'ouli (Melamprosops phaeosoma) by altering the invertebrate fauna on the forest floor (Scott et al. 1985; S. Mountainspring and J. Jacobi, pers. commun.).

To reduce these and other adverse effects of feral pigs on native ecosystems, researchers at Hawai'i Volcanoes National Park are testing methods to control pig populations. A number of methods are being examined, including trapping, snaring, and hunting. It has been found that trapping is heavily skewed toward removing younger and possibly more naive pigs. Trapping is less flexible and more expensive than snaring or hunting, and a certain percentage of pig populations seems unattracted to food baits in traps (J. Hone, pers. commun; Barrett, pers. commun.; Stone, unpubl. data). Snaring is initially labor-intensive but requires little follow-up. It can be effective over a long period of time with proper placement, setting, and adequate numbers of snares. Systematic hunting with dogs has produced the most dramatic results in pig reduction in Hawai'i. However, when pig populations are thinned out by hunting, it often becomes increasingly difficult to remove the last few pigs with the same method. Radio telemetry studies have shown that some pigs hide in dense cover such as uluhe (Dicranopteris linearis) and do not move while both dogs and hunters pass close to them. When hunts were initiated in Puhimau in 1983, there were no unsuccessful hunts in the first 4 months (n = 20). In the last 4 months of the year, 72% of the hunts were unsuccessful (n = 43).

One possible technique to improve the success of pig reduction programs with any of the above methods is to lure pigs into an area with a bait or other attractant. If consistency of pig use of a given area can be increased, hunting with dogs, for example, could be directed at baited areas, and efficiency of pig removal should increase after a period of baiting. The purpose of this preliminary study is to determine pig food preferences under controlled conditions with penned animals.

METHODS

Two series of tests were conducted over a two-month period (December 1985-January 1986) in a recently constructed pen facility at Hawai'i Volcanoes National Park. The circular research pen consists of 8 pie-shaped sections with a central holding area. Animals are separated by chain link fencing, with corrugated metal roofing used to strengthen the partitions and serve as visual barriers. Gates to the

individual pens are accessed through the holding area, and the holding area is accessed through two gates and a narrow chute-like passage. A 25-foot high portable blind was constructed in the central holding area and used to observe feeding behavior.

A total of 13 animals, 7 males and 6 females, were trapped and snared in Hawai'i Volcanoes National Park (HAVO) and nearby areas on the Big Island and used in the feeding trials. During the two-month period of testing, some animals were housed together by sex within the research pen or in another pen nearby. One of the eight sections was kept vacant and used as the test pen. Two series of trials were completed for each animal during the two months.

Each series of trials consisted of 3 one-hour observation periods per animal. Each animal was offered a choice of 7 foods which were weighed before and after each one-hour period. Animals were starved the night prior to initiation of each trial period but fed half rations after each of the three trials in each series. Foods offered in each of the two series are listed and discussed in the Results section. At the conclusion of the first series, a few of the foods deemed marginal were replaced with other bait candidates. Also, the usual food for penned animals (commercial pig chow with 16% protein) was included in the second series, to gauge its effect on the other choices as well as to determine its relative acceptability.

Foods used in the trials were prepared and presented to facilitate acceptance and to duplicate field baiting methods. Papaya were halved and deseeded and sweet potatoes were cooked. Since both are alien to native ecosystems, processing was necessary to reduce chances of spread by feral pigs. Also, sweet potatoes were found to have more food value in the cooked form (Cunha 1977). Hapu'u (Cibotium glaucum) was presented as logs in the first series of tests, and as more manipulable chunks in the second trials. Molasses was presented as purchased for livestock, in the form of a block.

After weighing each food item, foods were randomly ordered for each observation period and presented in a line from left to right near the back of the feeding pen. Then each test animal was gently coaxed into the feeding pen to begin the experiment. The feeding pen was cleaned after each trial to reduce olfactory effects of previous pigs. Water was provided in a five-gallon trough during each observation period.

In addition to weight data, actual times spent feeding on each food item were recorded. Numbers of bouts, or feeding intervals on a particular food item, were determined from these data. Time spent feeding was chosen as the major criterion in evaluating baits. Numbers of bouts also indicate

interest but sometimes these varied greatly in length. Food weight was difficult to assess and compare for some items because of inherent differences in food density and dehydration or hydration rates; but this measure can be used to support feeding time and bout data. The initial food investigated, but not eaten, was recorded for each observation period where appropriate. The same animals were used in both series of trials.

RESULTS

The results obtained provided insight into feral pig food preferences but because of small sample size, no statistical analysis was conducted. The four measures of feral pig interest (including initial food investigation) generally support each other, however, and lend credence to conclusions.

First Series.

As shown in Table 1, corn mash clearly interested 7 of the 13 pigs (one abstention) initially. A greater proportion of the females (5 of 6, or 83%) showed interest than males (2 of 6; 33%). The first bait investigated may prove useful as an indication of attractiveness, but more data are needed. Most (6 of 7) food items were novel to the animals, but some papaya was used for bait in capturing some animals.

Table 1. First bait investigated by feral pigs in first series of food tests, Hawai'i Volcanoes National Park, 1985.

FOOD ITEM	MALES*	FEMALES	COMBINED
Papaya	2	0	2
Macadamia Nuts	1	1	2
Macadamia Hulls	1	0	1
Liver	0	0	0
Corn Mash	2	5	7
Sweet Potatoes	0	0	0
Hapu'u	0	0	0

* No response from one animal.

Corn mash was indeed preferred over other food items over the 3 trials in the first series, based on feeding time data (Table 2). The mean time spent feeding on corn mash by each of the 13 test animals was 19.9 minutes. Papaya followed in preference with 14.2 minutes. The mean number of bouts showed similar results (Table 3): corn mash was most often eaten, followed by papaya. However, slightly more papaya than corn mash was eaten by weight (Table 4). Males and females favored corn mash equally according to time spent feeding, but males

returned to corn mash more often and ate more of it. Females spent more time eating papaya than males and consumed more of this food. Males appeared to favor hapu'u more than females did, according to time spent and number of bouts. It is commonly observed by local hunters that hapu'u accentuates the gamey odor and taste of feral boars. Sex differences in preference of other food items may occur, but more data are needed before generalizations can be made.

Table 2. Mean feeding time (minutes) by sex in first series of feeding trials, Hawai'i Volcanoes National Park, 1985.

FOOD ITEM	MALES*	FEMALES**	COMBINED
Papaya	10.3	18.7	14.2
Macadamia Nuts	3.4	0.9	2.2
Macadamia Hulls	1.2	2.5	1.7
Liver	3.6	6.6	4.9
Corn Mash	19.6	20.5	19.9
Sweet Potatoes	4.6	1.2	3.1
Hapu'u	8.3	2.5	5.6

* n = 7
** n = 6

Table 3. Mean number of feeding bouts by sex in first series of trials, Hawai'i Volcanoes National Park, 1985.

FOOD ITEM	MALES*	FEMALES**	COMBINED
Papaya	6.6	6.7	6.6
Macadamia Nuts	4.0	1.3	2.8
Macadamia Hulls	2.8	1.7	2.3
Liver	3.8	4.7	4.2
Corn Mash	12.8	9.5	11.3
Sweet Potatoes	5.1	1.2	3.3
Hapu'u	6.6	2.3	4.6

* n = 7
** n = 6

Table 4. Mean weight of food eaten (pounds) by sex in first series of feeding trials, Hawai'i Volcanoes National Park, 1985.

FOOD ITEM	MALES*	FEMALES**	COMBINED
Papaya	2.6	4.3	3.4
Macadamia Nuts	0.2	0.1	0.2
Macadamia Hulls	0.2	0.3	0.3
Liver	1.8	1.5	1.7
Corn Mash	4.1	2.2	3.2
Sweet Potatoes	1.4	0.6	1.1
Hapu'u	0.4	0.2	0.3

* n = 7
** n = 6

Second Series.

There appeared to be no highly preferred food in the second series of trials, based on initial investigations (Table 5). Responses to foods presented seemed more diverse during the second series. Corn mash was investigated first by 4 animals, and again more females seemed interested (3 of 6 animals) than males (1 of 6 animals). More males seemed initially interested in hapu'u (3 of 7 animals) than females did (1 of 6), and more males were interested in hapu'u initially than any other food.

Table 5. First bait investigated by feral pigs in second series of trials, Hawai'i Volcanoes National Park, 1985.

FOOD ITEM	MALES*	FEMALES**	COMBINED
Papaya	0	0	0
Pig Food	1	1	2
Molasses	1	0	1
Liver	1	0	1
Corn Mash	1	3	4
Zucchini	0	1	1
Hapu'u Chunks	3	1	4

* n = 7
** n = 6

The normal pen diet, commercial pig food, was preferred over all other choices (mean feeding time = 14 minutes) in the second series. Corn mash followed, with a mean feeding time of 9.4 minutes (Table 6). In the second series of tests, there appeared to be no real differences among papaya, liver, corn mash, and hapu'u chunks in feeding time. Numbers of bouts on each food showed similar results to those obtained by recording time spent feeding on each food (Table 7). Although the animals spent twice the amount of time eating commercial pig food (mean =14.0 minutes) as they did papaya (mean = 7.2 minutes), the weight data indicated that they ate somewhat

Table 6. Mean feeding time (minutes) by sex in second series of feeding trials, Hawai'i Volcanoes National Park, 1985.

FOOD ITEM	MALES*	FEMALES**	COMBINED
Papaya	6.0	8.7	7.2
Pig Food	11.7	16.7	14.0
Molasses	0.8	0.3	0.6
Liver	4.4	12.7	8.2
Corn Mash	6.4	12.9	9.4
Zucchini	0.6	0.1	0.3
Hapu'u Chunks	9.8	5.0	7.6

* n = 7
** n = 6

Table 7. Mean number of feeding bouts by sex in second series of trials, Hawai'i Volcanoes National Park, 1985.

FOOD ITEM	MALES*	FEMALES**	COMBINED
Papaya	5.8	5.7	5.8
Pig Food	12.5	11.0	10.8
Molasses	2.5	1.0	1.6
Liver	3.4	6.3	4.8
Corn Mash	6.4	8.5	7.4
Zucchini	1.1	0.3	0.8
Hapu'u Chunks	6.6	4.3	5.5

* n = 7
** n = 6

more papaya (Table 8). In this case, weight is likely an inaccurate measure of preference. Papaya could simply be eaten more rapidly than an equal weight of commercial pig food.

Table 8. Mean weight of food eaten (pounds) by sex in second series of feeding trials, Hawai'i Volcanoes National Park, 1985.

FOOD ITEM	MALES*	FEMALES**	COMBINED
Papaya	1.8	2.6	2.1
Pig Food	1.7	1.6	1.7
Molasses	0.1	0	0
Liver	0.9	2.9	1.8
Corn Mash	1.2	1.8	1.5
Zucchini	0.2	1.5	0.8
Hapu'u Chunks	0.9	0.7	0.8

* n = 7
** n = 6

Possible sex differences in food preference were noted in the second series of trials. Males and females appeared to prefer commercial pig food over papaya to the same degree, but males again favored hapu'u chunks more than females (as measured by time and numbers of bouts). Unlike the first series, in the second series of trials there was a difference in sex response to corn mash as measured by time. Females spent twice as much time (mean = 12.9 minutes) as males (mean = 6.4 minutes) eating corn mash. Interest by females in liver also increased in the second series of trials, as shown by time and weight data (Tables 6 and 8). Males exhibited the same level of response in both series, but females consumed more liver than males (mean = 2.9 pounds vs 0.9 pounds) in the second series. Preference for liver (mean feeding time = 12.7 minutes) by females was on a level with that for corn mash (mean feeding time = 12.9 minutes). It is not known what caused this change among females; perhaps, unlike some children, they learned to like it with exposure. A simplified summary of results is presented in Table 9 by test series, sex, and method of preference measurement.

DISCUSSION

The test animals as a group preferred corn mash in the first series and pig feed in the second. Both foods have a high level of sugar. Five pounds of sugar was used to make a 50-pound batch of mash, and molasses is fourth on the list of ingredients in the pig feed, after grain and protein

Table 9. Summary of baits preferred by penned feral pigs in first and second series of tests, Hawai'i Volcanoes National Park, 1985.

CRITERIA	MALES	FEMALES	COMBINED
1st Series			
Time	Mash	Mash	Mash
Bouts	Mash	Mash	Mash
Weight	Mash	Papaya	Papaya
2nd Series			
Time	Pig Food	Pig Food	Pig Food
Bouts	Pig Food	Pig Food	Pig Food
Weight	Papaya	Liver	Papaya

* n = 7
** n = 6

products. Pond and Houpt (1978) cited a number of studies that indicated an innate preference of pigs for sweet substances. A preference for saccharin is even exhibited in newborn pigs that have not yet nursed. There is a practical use for this behavior in the swine industry: a producer may be able to wean piglets sooner by including sweet substances in the starter ration (Cunha 1977). Sweetness is just one preferred characteristic of an effective bait; but this fact may prove useful in future testing.

PROBLEMS

A number of problems were encountered in these preliminary trials which made definitive statements about results difficult.

Animals. Probably the most significant limitation of this study was the small sample size. This, coupled with variable behavior of test animals and unknown influences on behavioral patterns, make results tentative. For example, prior food habits of individual pigs may have affected their responses. Kinds and availability of foods varied at capture sites. Animals taken in traps on the premises of Kulani Prison were baited with leftovers and garbage by prisoners. Pigs caught in that area frequented the refuse disposal site. This exposure to "human" food may have predisposed them to accepting other novel foods not found in their normal habitat.

Some animals were observed to be very nervous and cautious. Any distraction would result in pacing about the test pen. Others were very gregarious or curious and paid only the slightest attention to distractions. Apparently they

felt secure within the confines of the pen. The influence of temperament in a penned situation may alter feeding behavior and even food preferences from those exhibited in the wild.

There is a question of how social behavior affects feeding behavior. Pigs are social animals and are often seen feeding in family groups. In these trials, animals were tested individually and lacked visual and physical contact. This may have affected feeding and other behaviors.

Play behavior and wallowing affected feeding. On several occasions, food pans were tipped over and the contents strewn around the pen. Foods with high water content could not be weighed accurately subsequent to spillage. Several pigs were observed to display wallowing and rubbing responses to foods such as molasses and liver. The frequency and duration of these behavior patterns in captivity, where environment is simplified, may differ from those in the wild and affect feeding patterns.

Food Presentation. During the first series of trials, it was observed that test animals had a difficult time consuming the hapu'u logs. Logs were often pushed around the pen, and little starch consumption occurred. Pigs seemed to learn that hapu'u in log form was difficult to consume. It was concluded that the logs should be made more stationary to approximate forest conditions. In the second series of trials the starchy core was cut into chunks to see if this affected feeding success. Average time spent eating hapu'u increased by two minutes, and average weight of hapu'u consumed increased almost threefold over the first series. The low use of molasses in the second series may have been partly a function of presentation in large block form that pigs could not readily manipulate.

Another factor affecting preference is food texture. Off-grade zucchini were collected and frozen for the second series of trials. However, upon thawing it was noted that freezing had resulted in a "mushy" texture. This proved unacceptable to the test animals; frozen zucchini elicited the poorest response of all foods, with average time spent feeding only 0.3 minutes. Zucchini in its fresh form is crisp and firm and appeared more acceptable when given during non-test periods and to other animals.

Time of Day/Weather. Morrison et al. (1968) showed that most domestic pigs ate during midday. However, in our tests, one female was very shy and would not eat much, if anything, during the day. In the first series of trials, she usually lay down inside her shelter for the entire observation period. The commercial pig food was usually consumed at night. This was the case during the entire period the test animal was present at the facility, and this behavior was probably routine in her rain forest habitat. This pig fed

more in the daytime during the second series of trials but remained the most secretive of our test animals.

Kurz and Marchinton (1972) showed that feral pigs are diurnal although they may become more nocturnal during periods of hot weather. They may also become more nocturnal when hunted or otherwise disturbed by humans. No noticeable changes in behavior were detected with changing weather patterns in our study, other than seeking of shelter by some animals temporarily during very heavy downpours.

Other Problems. Although the pigs were visually and physically isolated from each other, they could communicate. Odors and vocalizations from adjacent pens may affect feeding behavior of the test animal. Movement of some animals from home pens to feeding test pen was traumatic. Some animals seemed to learn the routine, but others needed considerable coaxing and required several minutes to calm down in the test pen. Another factor that is difficult to assess is the effect of subclinical disease on appetite and food palability. It is known that feral pigs have a high incidence of kidney worms. Perhaps nephritic occlusion would alter their food preferences in favor of dry or moist foods. Lameness is also a common problem with captive pigs and may alter feeding patterns.

CONCLUSIONS AND RECOMMENDATIONS

Useful information was obtained from these experiments; however, it should be reiterated that results are quite preliminary. The primary limitation to the findings is the small sample size. On the other hand, numerous replications may not reduce the high variation in response, and certainly all possible foods cannot be tested. Use of research information in preliminary stages is often necessary to avoid delay in management of critical problems. More data are definitely needed to improve management methods, however. Another constraint is the supply of test animals. The time needed to capture feral animals in native ecosystems is considerable, and captive animals should be well utilized. In the future, scents as well as food bait attractants will be tested. Foods and scents that elicit favorable responses will be repeatedly tested and apparent "dead ends" eliminated. Subsequent testing will include new candidate baits as well as preferred previous baits.

Corn mash, pig feed and papaya are all relatively sweet food items. "Sweetness" may be an effective characteristic of a good bait. Future testing should elucidate other good bait characteristics, e.g. odor. Scents could be combined with sweet or other baits to determine effects. Cost, availability, preparation time, "shelf life", and transportability are among other factors that must be considered in developing suitable baits. Variations in testing protocol may eliminate

or reduce biases such as social effects and human disturbances. In the end, a number of good baits will probably enhance present feral pig control methods.

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